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**EUROPEAN PATENT APPLICATION**

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⑦① Applicant: **Montedison S.p.A., 31, Foro Buonaparte, I-20121 Milan (IT)**  
Applicant: **MITSUI PETROCHEMICAL INDUSTRIES, LTD., 2-5, Kasumigaseki 3-chome Chiyoda-ku, Tokyo 100 (JP)**

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⑦② Inventor: **Albizzati, Enrico, 45, Via F. Baracca, Arona (Novara) (IT)**  
Inventor: **Parodi, Sandro, 1/e, Via Vecchia Circonvallazione, Oleggio (Novara) (IT)**  
Inventor: **Barbe, Pier Camillo, 3, Via Pavone, Ferrara (IT)**

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⑦④ Representative: **Zumstein, Fritz sen., Dr. et al, Dr. F. Zumstein sen. Dr. E. Assmann Dipl.-Ing. F. Klingseisen Dr. F. Zumstein jun. Bräuhäusstrasse 4, D-8000 München 2 (DE)**

⑤④ **Components and catalysts for the polymerization of olefins.**

⑤⑦ Catalysts for the polymerization of alpha-olefins, which comprise the product of the reaction between:

- a) a metallorganic compound of Al;
- b) an electron-donor compound reactive towards  $MgCl_2$  but which results not to be completely complexed with  $AlEt_3$  at the equivalent point of a potentiometric titration under standard conditions;
- c) a solid comprising a halogenated Ti compound and an electron-donor compound, both supported on a Mg dihalide, the electron-donor belonging to particular classes of compounds and being extractable with  $AlEt_3$  for at least 70% by mols from the solid, the surface area of which after extraction is higher than  $20 \text{ m}^2/\text{g}$ .

**EP 0 086 473 A2**

5       The present invention refers to new supported components of catalysts for the polymerization of olefins  $\text{CH}_2=\text{CHR}$ , in which R is an alkyl with 1-4 carbon atoms or an aryl, and of mixtures of such olefins with each other and/or with ethylene, and to the catalysts obtained from such components.

10       In earlier patent applications in the name of the Applicant there have been disclosed catalysts endowed with high activity and high stereospecificity, obtained from metallorganic Al compounds, silicon compounds containing  
15       Si-O-C, Si-OCOR or Si-NR<sub>2</sub> bonds and from a solid comprising a halogenated titanium compound and an electron-donor compound, both supported on an active Mg halide, the electron-donor compound being chosen among specific classes of  
20       esters.

      It has now been unexpectedly found that it is possible to prepare highly active and highly stereospecific catalysts also by employing electron-donor compounds different from  
25       those described in the earlier patent applications, provided that the employed electron-donor compound belongs to certain classes of compound, as specified hereinafter, and is for at least 70% by mols extractable from the solid catalyst component by reaction under standard conditions with Al-triethyl,  
30       and that the surface area of the product after extraction is not less than 20 m<sup>2</sup>/g.

      The catalysts of the invention comprise the product of the reaction between at least the following components:

35       ...

- 5 a) an Al-alkyl compound, preferably an Al-trialkyl or a compound containing two or more Al atoms linked to each other through oxygen or nitrogen atoms or through  $SO_4$  or  $SO_3$  groups;
- 10 b) an electron-donor compound (or Lewis base) which, under the standard conditions of measurement as indicated herein after, is reactive towards  $MgCl_2$  but which results not to be completely complexed with  $AlEt_3$  at the equivalent point of a potentiometric titration under standard conditions;
- 15 c) a solid comprising a Ti halide and an electron-donor compound both supported on a Mg halide, such electron-donor compound being selected from the classes of: ethers, ketones, lactones, electron-donor compounds containing
- 20 N, P and/or S atoms, and from the following esters:
- 1) hydrocarbyl esters of linear saturated dicarboxylic acids, containing from 2 to 5 C atoms;
  - 2) esters of unsaturated polycarboxylic acids, in which
- 25 two carboxyl groups are linked to vicinal, double bond-forming carbon atoms and in which the hydrocarbyl radical or radicals of the  $COOR$  groups are linear saturated or unsaturated radicals or cycloaliphatic
- 30 radicals with 1-20 C atoms or hydrocarbyl esters of unsaturated linear or branched polycarboxylic acids with 1-20 carbon atoms, in which the carboxy groups are not linked to vicinal double bond-forming carbon atoms;
- 35

...

- 5 3) hydrocarbyl esters of aromatic meta- and para-dicarboxylic acids and hydrocarbyl esters of aromatic polycarboxylic acids containing more than two carboxyl groups;
- 10 4) hydrocarbyl esters of aromatic hydroxy compounds containing the OH groups in meta- or para-position, and esters of aromatic hydroxy acids, the OH groups of which, are in meta- or para-position with respect to the carboxyl group;
- 15 5) esters  $\text{RCOOR}'$  the hydrocarbyl groups R and R' of which, which can be the same or different, are linear saturated or unsaturated radicals or cycloaliphatic radicals having from 1 to 20 carbon atoms, or R is an aryl, alkylaryl or cycloalkyl with 5-20 carbon atoms and R' is a hydrocarbyl radical or a heterocyclic ring with 5-7 atoms in the ring;
- 20 6) hydrocarbyl esters of polycarboxylic acids in which at least one carboxyl group is linked to an aromatic ring and at least one other is linked to a carbon atom of an aliphatic group or to a cycloaliphatic ring or at least two carboxyl groups are linked to an aromatic ring through an alkylene group;
- 25 7) esters of aromatic polycarboxylic acids containing at least two non-condensed aromatic rings, each of which bearing a carboxyl group;
- 30 8) esters of carbonic acid with glycols and carbonic acid derivatives of formula  $\text{RO-CO-OR}'$  wherein R and R' are
- 35

...

5 the same or different acyl groups with 1-20 carbon atoms;  
9) esters of polyols and of monohydroxy-phenols;  
10) hydrocarbyl esters of acetylenic acids; the electron-  
-donor compound being extractable from the solid for  
10 at least 70% by mols with Al-triethyl under standard  
measurement conditions, and the surface area of the  
solid subjected to extraction being higher than 20  
m<sup>2</sup>/g.

15 Electron-donor compounds belonging to the above speci-  
fied classes and suitable for the preparation of the cata-  
lyst components of the invention are: diisoamyl ether, diiso-  
butyl ether, benzophenone, triphenyl phosphite, phenyl pro-  
pionate, di-n-butyl succinate, diisobutyl succinate, di-n-bu-  
20 tyl malonate, diethyl allylmalonate, di-n-butyl maleate,  
ethyl and propyl trichloroacetate, POCl<sub>3</sub>, triphenylphosphine,  
λ-methyl-λ-phenyl-butyrolactone, 1,6-hexandiol di-p-tolua-  
te, 1,4-butanediol di-p-toluate, ethyl benzoyl carbonate  
25 (C<sub>6</sub>H<sub>5</sub>CO-O-CO-OC<sub>2</sub>H<sub>5</sub>), diisobutyl ester of o.phenylen diacetic  
acid. It is understood that the above classes of esters in-  
clude also the derivatives thereof as for instance the deri-  
vatives containing halogen atoms or unsaturated hydrocarbyl  
30 radicals. Ethyl trichloroacetate and diethylallyl malonate  
listed above are examples of such derivatives.

All the above compounds are extractable from the solid  
catalyst component for at least 70% by mols by reaction with  
35 Al-triethyl. The surface area of the solid after the treat-

...

5 ment with Al-triethyl is higher than  $20 \text{ m}^2/\text{g}$  and in the case of very active catalysts higher than  $100 \text{ m}^2/\text{g}$  and in general comprised between 100 and  $300 \text{ m}^2/\text{g}$ .

10 In the case of weak electron-donors, as certain ethers, it has been found that the ether can be substantially removed from the catalytic solid during the preparation if the latter comprises treatments with excess  $\text{TiCl}_4$  and/or washings with halogenated solvents. Nevertheless, also these catalyst components fall within the scope of the present invention.

15 It is understood that the above donor compounds, when subjected to the extractability test with Al-triethyl before the above mentioned treatments, comply with the test.

It has been found that it is possible to obtain catalyst components according to the invention also by employing certain electron-donor compounds, such as alkyl, cycloalkyl or aryl esters of aromatic monocarboxylic acids, which in the preparation conditions hitherto known do not form catalyst components satisfying the requirements of this invention.

25 The components according to the invention and containing the above esters are prepared by methods which consist in hot washing with a halogenated hydrocarbon solvent a co-ground mixture comprising the ester, the Ti compound and

30 the Mg halide.

For Ti halides and electron-donor compounds supported on a Mg dihalide are meant the compounds not extractable from component c) after treatment with boiling 1,2-dichloroethane

35 for 2 hours (concentration of the solid in the suspension:

...



5 5% by weight).

The compounds reactive towards  $\text{MgCl}_2$  are those which under the standard conditions of the reaction remain fixed on the Mg halide for at least 20% by mols.

10 Components a), b) and c) are reacted with each other in whichever order; nevertheless, components a) and b) are preferably pre-mixed before being contacted with component c).

Component c) can be pre-mixed with component a) and/or with component b). The pre-mixing of a) and b) is carried  
15 out at temperatures usually comprised between room temperature and the temperature employed in the polymerization.

The pre-reaction of c) and b) can be carried out also at higher temperatures. Compound b) can also be incorporated  
20 in and reacted with component c) itself.

Component b) is reacted in a molar ratio with respect to the halogenated Ti compound supported on component c) of at least 1, and in a molar ratio with respect to the Al-alkyl  
25 compound employed as component a) lower than 20 and preferably comprised between 0.05 and 1. Ratios higher than 1 can be employed with compounds b) not complexing or only weakly complexing Al-triethyl also under conditions promoting such complex formation.

30 In component c) the molar ratio between the Mg dihalide and the halogenated Ti compound supported on it is comprised between 1 and 500, and the molar ratio between the halogenated Ti compound and the electron-donor both supported on the  
35

...

5 Mg dihalide is comprised between 0.1 and 50.

10 The electron-donor compounds as defined in b) does not show at the equivalent point of the titration test with Al-triethyl (carried out under the standard conditions indicated hereinafter) any logarithmic variation of potential, i.e. a wave, in the titration curve.

15 A completely different situation occurs in the case of amines like isoquinoline or esters like ethyl-p-toluate or ethylbenzoate, wherein the titration curve shows a wave at the equivalent point. The absence of a wave at the equivalent point indicates that electron-donor compound b) is present, at least in part, in not complexed form with Al-triethyl.

20 Electron-donor compounds containing active hydrogen atoms reactive towards Al-triethyl, i.e. capable of substitution reactions with Al-triethyl, are prereacted with Al-triethyl, before subjecting the same to the complexation test. In the titration test the equivalent point is generally referred to the use of 1 mol of Al-triethyl per mol of donor.

30 Compounds b) can be used in mixture, in a wide range, with donors forming complexes with Al-triethyl when titrated according to the test set forth above.

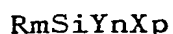
The titration of the mixtures containing significant amounts of the complexing donors, shows the potential variation due to the presence of said complexing donors.

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5           However the polymerization performance of the catalysts obtained by using the above mixtures as component b) is not significantly reduced by the presence of the complexing donor.

10           The compound b) is selected in particular from compounds of general formula:



wherein:

15           R is an alkyl, alkenyl, aryl, arylakyl or cycloalkyl radical with 1-20 carbon atoms;

Y is a  $-\text{OR}'$ ,  $-\text{OCOR}'$  or  $-\text{NR}'_2$  radical in which  $\text{R}'$ , the same as or different from R, has the same meaning as R;

20           X is a halogen or hydrogen atom or a  $-\text{OCOR}''$  or  $-\text{NR}''_2$  group in which  $\text{R}''$ , the same as or different from  $\text{R}'$ , has the same meaning as  $\text{R}'$ ; m, n, p are numbers comprised :  
m from 0 to 3, n from 1 to 4 and p from 0 to 1; m+n+p is equal to 4.

25           Preferred silicon compounds are: phenyl alkoxy silanes, as phenyl triethoxy or phenyl trimethoxy silane, diphenyl dimethoxy and diphenyl dimethoxy and diphenyl diethoxy silane, monochlorophenyl diethoxy silane; alkyl alkoxy silanes, as ethyl triethoxy silane, ethyl triisopropoxy silane.

30           In the catalysts according to the invention the silicon compound is present in combined form in the solid product of the reaction between the various components forming the catalyst in a molar ratio between the silicon compound and the

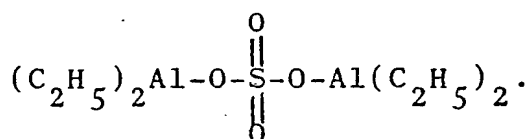
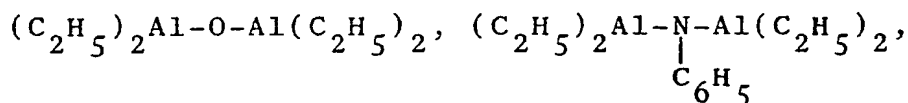
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5 halogenated Ti compound higher than 0.05 and in general comprised between 0.1 and 5.

Other suitable compounds b) are: 2,2,6,6-tetramethylpiperidine, 2,2,5,5-tetramethylpyrrolidine, 2,2,6,6-tetramethylpiperidide-Al-diethyl, Al-dichloro-monophenoxy.

The Al-alkyl compounds of component a) include the Al-trialkyls, such as for instance  $\text{AlEt}_3$ ;  $\text{Al}(\text{i-Bu})_3$ ,  $\text{Al}(\text{i-C}_3\text{H}_7)_3$ ,  $\text{AlEt}_2\text{H}$ , and compounds containing two or more Al atoms linked to each other through etero-atoms, such as:



As indicated, Al-alkyl compounds in which Al atoms are linked through groups like  $\text{SO}_4$  or  $\text{SO}_3$  are also suitable.

The Al-alkyl compounds can be employed in admixture with Al-alkyl halides, as  $\text{AlEt}_2\text{Cl}$ .

Component c) is prepared according to various methods. One of these consists in co-grinding the Mg halide and the electron-donor compound until the product, after extraction with Al-triethyl under standard conditions, shows a surface area higher than  $20 \text{ m}^2/\text{g}$ , and in reacting subsequently the ground product with the Ti compound.

Preparations of this type are described in British Patent No.1,559,194.

...

5 Another method consists in reacting an adduct Mg halide/  
/alcohol with a Ti compound in the presence of the electron-  
-donor compound. This method is described in Belgian Patent  
No. 868,682.

10 According to another method, described in the published  
German pat. appln. No. 3,022,738, the adduct Mg dihalide/al-  
cohol is reacted in liquid form with the halogenated Ti com-  
pound and with the electron-donor compound.

Other methods are described in published German pat.  
15 appln. No. 2,924,029, U.S. Patent No. 4,220,554 and Italian  
pat. appln. No. 27261/79.

Another method consists in co-grinding the Mg dihalide,  
the halogenated Ti compound and the electron-donor compound  
20 until activation of the Mg dihalide, in treating a suspen-  
sion of the ground product in a halogenated hydrocarbons, as  
1,2-dichloroethane, chlorobenzene, methylene dichloride,  
hexachloroethane, and in separating the solid from the li-  
quid halogenated hydrocarbon. This method is particularly  
25 suitable for preparing catalyst components satisfying the ex-  
tractability criterion of the present invention when as elec-  
tron-donor compounds are employed esters of aromatic mono-  
carboxylic acids, such as for instance alkyl esters of ben-  
zoic acid.  
30

The treatment is carried out at temperatures comprised  
between 40 °C and the boiling point of the halogenated hydro-  
carbon for a time ranging in general from 1 to 4 hours.  
35

...

5 According to another method, a porous carrier as  $\text{SiO}_2$   
or  $\text{Al}_2\text{O}_3$  having a low content of OH groups (preferably less  
than 1% by weight) is impregnated with a liquid adduct Mg  
dihalide/alcohol; then the carrier is treated with an excess  
10 of  $\text{TiCl}_4$  containing in solution the electron-donor compound  
according to the procedure described for example in German  
pat. appln. No. 3,022,738 or in Belgian Patent No. 868,682.

In all the above methods the final product contains a  
Mg dihalide in the active form as defined hereinafter. For  
15 "active form of the Mg dihalide" is meant the Mg dihalides  
showing in the X-ray powder spectrum of component c) a broad-  
ening of at least 30% of the most intense diffraction line  
appearing in the powder spectrum of the corresponding dihalide  
20 having a surface area of  $1 \text{ m}^2/\text{g}$ , or is meant the Mg diha-  
lides showing a X-ray spectrum in which said most intense  
diffraction line is replaced by a halo with its intensity  
peak shifted with respect to the interplanar distance of  
25 the most intense line.

Very active forms of Mg dihalides are those showing a  
X-ray powder spectrum in which the most intense diffraction  
line appearing in the spectrum of the corresponding halide  
30 having a surface area of  $1 \text{ m}^2/\text{g}$  has a decreased intensity  
and is broadened to form a halo, or are those in which said  
most intense line is replaced by a halo having its intensi-  
ty peak shifted with respect to the interplanar distance of  
35 the most intense line.

...

5 In general, the surface area of the above forms is higher than 30-40 m<sup>2</sup>/g and in particular is comprised between 100 and 300 m<sup>2</sup>/g.

Preferred Mg dihalides are MgCl<sub>2</sub> and MgBr<sub>2</sub>. The water content of the dihalides in general is lower than 1% by weight.

10 Other known methods for preparing a Mg dihalide in active form or catalyst components containing Ti and supported on a Mg dihalide, in which components the dihalide is present in active form, are based on the following reactions:

- 15 - reaction of a Grignard compound or of a compound MgR<sub>2</sub> (R is hydrocarbyl) or of complexes MgR<sub>2</sub>/Al-trialkyls with halogenating agents, as AlX<sub>3</sub> or compounds AlR<sub>m</sub>X<sub>n</sub> (X is halogen, R is hydrocarbyl, m+n=3), SiCl<sub>4</sub> or HSiCl<sub>3</sub>;
- 20 - reaction of a Grignard compound with a silanol or a poly siloxane, H<sub>2</sub>O or with an alcohol and subsequent reaction with a halogenating agent or with TiCl<sub>4</sub>;
- reaction of Mg with an alcohol and with a hydrogen halide, or of Mg with a hydrocarbyl halide and with an alcohol;
- 25 - reaction of MgO with Cl<sub>2</sub> or AlCl<sub>3</sub>;
- reaction of MgX<sub>2</sub>.nH<sub>2</sub>O (X is halogen) with a halogenating agent or with TiCl<sub>4</sub>;
- 30 - reaction of Mg mono- or dialcoholates or of Mg carboxylates with a halogenating agent.

Titanium halides and halogen-alcoholates are in particular the Ti tetrahalides, the Ti trihalides and the Ti trihalogen-alcoholates. Preferred compounds are: TiCl<sub>4</sub>, TiBr<sub>4</sub>, 2,6-dimethylphenoxytrichlorotitanium and trichloro-phenoxy-

35 -titanium.

...

5       The Ti trihalides are obtained by known methods, for instance by reduction of  $\text{TiCl}_4$  with Al or with a metallor-  
ganic compound of Al or with hydrogen.

10       In the case of the Ti trihalides it can be expedient, to improve the performance of the catalysts, to carry out an oxidation, even partial, of the titanium during or after the preparation of component c). To this purpose halogens and iodine halides can be employed.

15       Preferred catalysts are those in which component c) is obtained from  $\text{MgCl}_2$ ,  $\text{TiCl}_4$  or  $\text{Cl}_3\text{TiOC}_6\text{H}_5$  and esters of maleic or malonic acid or from diisoamyl ether or benzophenone, and in which component b) is phenyl- or ethyl-triethoxy-silane or diphenyl-dimethoxy-silane or diphenyl-diethoxy-silane.

20       Component a) is an Al-trialkyl, as Al-triethyl or Al-triisobutyl.

25       The preferred methods for the preparation of component c) are those described in British Patent No. 1,559,194, Belgian Patent No. 868,682, published German pat. Appln. No. 2,924,029, U.S. Patent No. 4,220,554, Italian pat. appln. No. 27261/79 or published German pat. appln. No. 3,022,738.

30       Among the preferred methods for preparing component c) there is also the co-grinding of  $\text{MgCl}_2$ ,  $\text{TiCl}_4$  and electron-donor and the treatment of the ground product with a halogenated hydrocarbon, as 1,2-dichloroethane.

35       The catalysts according to the invention are employed to polymerize alpha-olefins by known methods, that is by carrying out the polymerization in liquid phase, either in

...



5 the presence or in the absence of an inert hydrocarbon solvent, or in gas phase or also by combining, for instance, a polymerization step in liquid phase with a step in gas phase.

10 In general, the temperature is comprised between 40° and 160 °C, but preferably between 60° and 90 °C, operating either at atmospheric pressure or at higher pressure.

As a molecular weight regulator can be employed hydrogen or another regulator of known type.

15 The catalysts are particularly suitable for the polymerization of propylene, butene-1, styrene and 4-methyl-pentene-1. The catalysts can also be employed for polymerizing, by known methods, mixtures of propylene and ethylene to produce modified polypropylenes having improved impact resistance at low temperatures (the so called propylene/ethylene block copolymers) or to obtain crystalline random copolymers of propylene with minor amounts of ethylene.

25 The test for the determination of the complexability of compound b) is carried out by using a potentiograph Metrohm mod. E 536 equipped with titration bench E 535, automatic burette E 552, magnetic stirrer E 549 and titration cell EA 880. It is employed a combined electrode EA 281 (Pt//Ag/AgCl/  
30 /KCl 3M).

As titrating agent is employed a 0.5 M hexane solution of Al-triethyl which is added to a 0.5 M benzene solution of the compound under examination. It is operated at room temperature under nitrogen atmosphere. The test of reactivity of  
35

...

5 the electron-donor compound with  $\text{MgCl}_2$  is carried out under the following conditions.

Into a flask of 500 cc capacity are introduced, under nitrogen atmosphere, 2 g  $\text{MgCl}_2$  (21 m Moles) suspended in 200 cc toluene and 3.5 m Moles of the electron-donor under  
10 examination. It is allowed to react at 25 °C for 1 hour and the solid is filtered and washed with 200 cc toluene and then with 200 cc n-heptane. The solid is isolated, dried and analyzed.

15 As  $\text{MgCl}_2$  is employed the product obtained from  $\text{MgCl}_2 \cdot 2.5 \text{C}_2\text{H}_5\text{OH}$  by reaction with Al-triethyl according to the following procedure:

into a 3000 cc flask are introduced 2340 cc of a 0.83 M hexane  
20 ne solution of  $\text{Al}(\text{C}_2\text{H}_5)_3$ ; while maintaining the temperature below 10 °C, 136 g  $\text{MgCl}_2 \cdot 2.5 \text{C}_2\text{H}_5\text{OH}$  are added little by little. After the addition is completed, it is heated at 70 °C for 4 hours; then the solid is filtered, washed repeatedly  
25 with n-heptane and dried under a vacuum of 0.2-0.5 Torr.

The surface area of the obtained  $\text{MgCl}_2$  amounts to 618  $\text{m}^2/\text{g}$  and the pores volume to 0.532 cc/g.

#### Examples 1-16 and Comparative Examples 1-4.

#### PREPARATION OF THE SOLID CATALYST COMPONENT

30 Into a vibrating mill having a total volume of 1 liter and containing 3 Kg steel balls of 16 mm diameter were introduced, under nitrogen atmosphere, 50 g anhydrous  $\text{MgCl}_2$ , an elec  
35 tron-donor compound in such an amount as to have a molar ra-  
...

5   tio  $\text{MgCl}_2$ /monofunctional electron-donor equal to 6 and a molar ratio  $\text{MgCl}_2$ /bifunctional electron-donor equal to 12, and  $\text{TiCl}_4$  in the molar ratio 1/1 with respect to the electron-donor compound. It was ground for 72 hours.

10   10 g of the co-ground product were treated with 100 cc 1,2-dichloroethane for 2 hours at 80 °C; it was filtered at the same temperature and after several washings with n-heptane the solid catalyst component was suspended in heptane.

15   POLYMERIZATION

Into a stainless steel autoclave of 3000 cc holding capacity, equipped with magnetic anchor stirrer and thermometer, heat stabilized at 60 °C, into which propylene was made to flow, 20 was introduced a suspension consisting of 1000 cc anhydrous and deaerated n-heptane, 5 millimoles aluminum triethyl, the desired amount of the silicon compound and the solid catalyst component.

25   Hydrogen was then introduced at a pressure of 0.2 atmopsheres and it was heated rapidly at 70 °C while simultaneously feeding in propylene up to a total pressure of 7 atmopsheres. Said pressure was kept constant over the whole polymerization time by feeding in continuously the monomer. After 4 hours 30 the polymerization was stopped and the polymer was isolated by filtration and dried. The quantity of polymer dissolved in the filtrate was isolated, weighed and summed to the polymer soluble in boiling n-heptane for the calculation of the iso-

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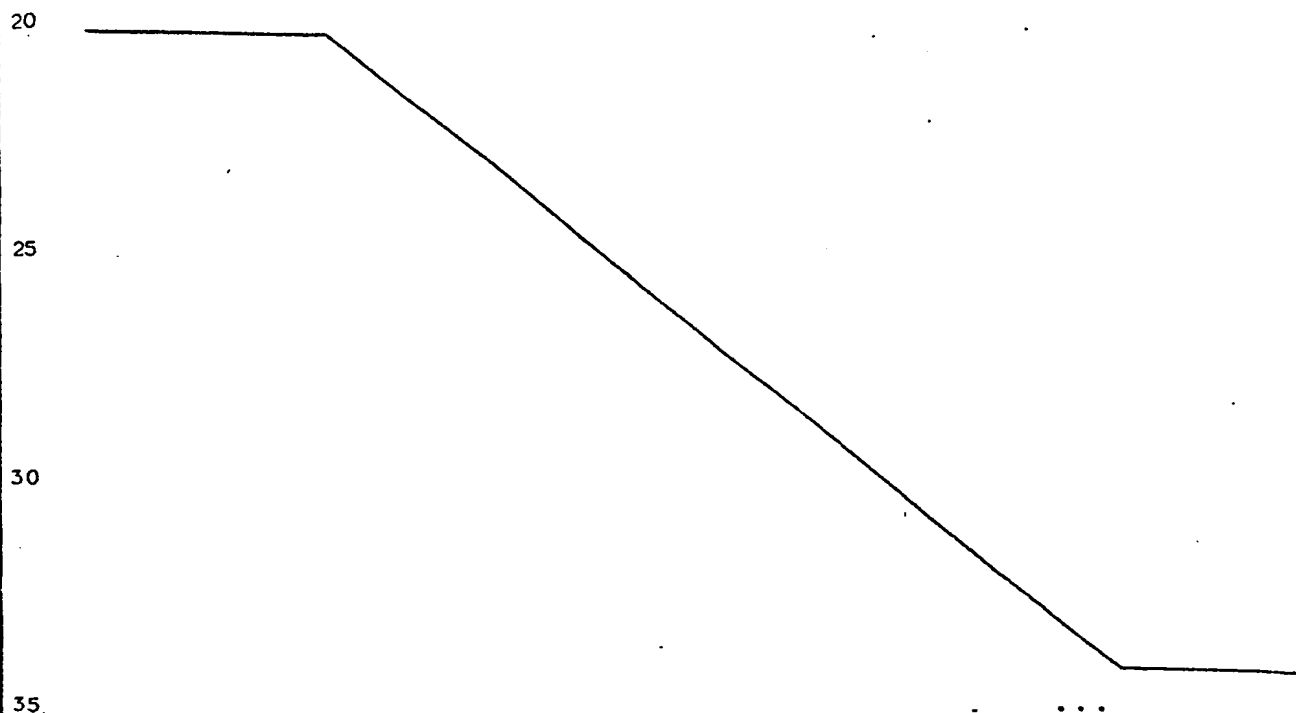
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5 tacticity index (I.I.).

The results of the polymerization runs are reported in the Table.

10 In the Table are also reported the results of the tests of extractability with Al-triethyl. The tests were carried out under the following standard conditions:

into a 5 liter flask are introduced 4 liter anhydrous and deaerated n-heptane containing 20 m Moles  $\text{Al}(\text{C}_2\text{H}_5)_3$ . The temperature is raised to 70 °C, about 1 g of solid  
15 catalyst component is introduced and the whole is allowed to react under stirring for 15 minutes. Thereupon it is cooled rapidly at 0°C and is filtered, thus isolating a solid which is dried under vacuum at 25 °C and analyzed.



Example No.	S O L I D   C A T A L Y S T   C O M P O N E N T			
	Electron-donor (ED)		Extraction with $\text{Al}(\text{C}_2\text{H}_5)_3$	
	T y p e	% by weight (1)	% by weight (3)	Surface area( $\text{m}^2/\text{g}$ )
1	Di-n-butyl maleate	6.2	0	186
2	Di-n-butyl itaconate			
3	Diethyl allylmalonate			
4	Di-n-butyl malonate			
5	Diisobutyl succinate			
6	Di-n-butyl succinate			
7	Benzophenone			
8	Ethyl trichloroacetate	9.2	0.54	186
9	Ethyl benzoate	8.8	0.8	163
10	Diisoamyl ether (2)	1	0	163
11	$\alpha$ -Methyl- $\alpha$ -phenyl- - $\gamma$ -butyrolactone	7.3	0.9	90
12	$\text{POCl}_3$			
13	Triphenylphosphine			
14	Ethyl acetate	4.2	0	229
15	$\text{C}_6\text{H}_5-\overset{\text{O}}{\underset{\text{O}}{\text{C}}}-\text{O}-\overset{\text{O}}{\underset{\text{O}}{\text{C}}}-\text{OC}_2\text{H}_5$	9.4	0.3	174
16	Diisobutyl o.fenylene diacetate	6.7	0.9	165
1 compar.	2-Ethylhexyl terephthalate	9.2	0.26	1
2 compar.	Phenothiazine	7.7	3.6	
3 compar.	Diisobutyl 0,0-diphenyldicarboxylate	6.6	2.4	
4 compar.	Isobutyl m-acetoxybenzoate	8.8	4.2	

...

Example No.	P O L Y M E R I Z A T I O N				
	Silicon compound	Al/Si Molar ratio	Yield g PP/g catalyst component	I.I. (%)	$\eta_{in}$ (dl/g)
1	$(C_6H_5)_2Si(OCH_3)_2$	10	8600	95.1	1.5
2	do	10	4600	93.6	1.4
3	do	10	8500	97.3	1.6
4	do	10	5000	91.2	1.3
5	do	10	4000	90	1.2
6	do	10	3600	91.5	1.3
7	do	3.3	3600	93.8	1.2
8	$(C_6H_5)Si(OC_2H_5)_3$	3.3	5600	92.2	1.1
9	do	10	4500	95.5	1.1
10	do	5	5200	91	1.3
11	do	5	3600	91.8	1.2
12	do	5	4000	92	1.5
13	do	5	3600	90.5	1.2
14	do	10	3200	96.6	1.2
15	do	20	5500	91.3	1.5
16	do	20	3500	90.7	1.2
1 compar.	do	10	2300	88	1.1
2 compar.	do	10	1300	71.8	1.2
3 compar.	do	10	trace	-	-
4 compar.	do	10	550	84.4	1.2

(1) The percent amount of ED is referred to the solid after washing with 1,2-dichloroethane.

(2) The diisoamyl ether content of the ground product, before washing with 1,2-dichloroethane, was 17%.

(3) Percent of ED remaining on the solid of the extraction with  $Al(C_2H_5)_3$ .

...

C L A I M S

- 5 1) A solid component to be employed, in combination with metallorganic Al compounds and with electron-donor compounds which results not to be completely complexed with Al-triethyl at the equivalent point of a potentiometric titration under standard conditions but reactive  
10 towards anhydrous Mg chloride, to form catalysts for the polymerization of alpha-olefins  $\text{CH}_2 = \text{CHR}$ , said component comprising a titanium compound having at least a Ti-halogen bond and an electron-donor compound both  
15 supported on an anhydrous Mg dihalide, the electron-donor compound being selected from the group consisting of electron-donor compounds containing N, P and/or S atoms, ethers, ketones, lactones and the following classes of esters :
- 20 1) hydrocarbyl esters of linear saturated dicarboxylic acids having from 2 to 5 carbon atoms;
- 25 2) esters of unsaturated polycarboxylic acids in which two carboxyl groups are linked to vicinal, double bond forming carbon atoms and in which the hydrocarbyl radical or radicals of the COOR groups are linear saturated or unsaturated radicals or cycloaliphatic  
30 radicals with 1-20 carbon atoms or hydrocarbyl esters of unsaturated linear or branched polycarboxylic acids with 1-20 carbon atoms in which the carboxy groups are not linked to vicinal double bond-forming carbon atoms;
- 35

...

- 5        3) hydrocarbyl esters of aromatic meta- and para-dicarboxylic acids and hydrocarbyl esters of polycarboxylic aromatic acids containing more than two carboxyl groups;
- 10       4) hydrocarbyl esters of aromatic hydroxy compounds containing the OH groups in meta- or para-position, and esters of aromatic hydroxy acids the OH groups of which are in meta- or para-position with respect to the carboxyl group;
- 15       5) esters  $\text{RCOOR}'$  in which the hydrocarbyl groups R and  $\text{R}'$ , which can be the same or different, are linear saturated or unsaturated radicals or cycloaliphatic radicals having from 1 to 20 carbon atoms, or R is
- 20       an aryl, alkylaryl or cycloalkyl with 5-20 carbon atoms and  $\text{R}'$  is a hydrocarbyl radical or a heterocyclic ring with 5-7 atoms in the ring;
- 25       6) hydrocarbyl esters of polycarboxylic acids in which at least one carboxyl group is linked to an aromatic ring and at least one other is linked to a carbon atom of an aliphatic chain or to a cycloaliphatic ring or at least two carbonyl groups are linked to an aromatic ring through an alkylene group;
- 30       7) esters of aromatic polycarboxylic acids containing at least two non-condensed aromatic ring, each of which bearing a carboxyl group;
- 35       8) esters of carbonic acid with glycols; and carbonic acid derivatives of formula  $\text{RO-CO-OR}'$  wherein R

...



5 and R' are the same or different acyl group with  
1-20 carbon atoms;

9) esters of polyols and of monohydroxy-phenols;  
10) hydrocarbyl esters of acetylenic acids; the elec-  
tron-donor compound being extractable from the so-  
lid for at least 70% by mols with Al-triethyl in  
standard measurement conditions, and the surface  
area of the solid subjected to extraction being  
higher than 20 m<sup>2</sup>/g.

15 2) A catalyst component according to claim 1, in which  
the electron-donor compound is selected from the group  
consisting of diisoamyl ether, benzophenone, triphenyl  
phosphite, di-n-butyl malonate, diethyl allylmalonate,  
20 di-n-butyl maleate, ethyl trichloroacetate, propyl tri-  
chloroacetate, POCl<sub>3</sub>, 1,6-hexandiol di-p-toluate, and  
the Ti compound is Ti tetrachloride or trichloro-arylo  
xy-titanium.

25 3) Catalysts for the polymerization of alpha-olefins, com-  
prising the product of the reaction of:  
a) a metallorganic Al compound, in particular an Al-  
30 -trialkyl or an Al-alkyl compound containing two or  
more Al atoms linked to each other through oxygen  
or nitrogen atoms or through SO<sub>4</sub> or SO<sub>3</sub> groups;  
b) an electron-donor compound reactive, under standard  
conditions, towards MgCl<sub>2</sub> but not completely complex-  
35 ed with Al-triethyl;

..

c) the catalyst component of the preceding claims 1, 2.

- 4) Catalysts according to claim 3, in which component b) is selected from silicon compounds containing at least one Si-OR or Si-OCOR or Si-NR<sub>2</sub> bond in which R is an alkyl, alkenyl, aryl, arylalkyl or cycloalkyl radical with 1-20 carbon atoms.

Milan, January 19, 1983

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